LOW ANGLE INTERSECTING AND SKEW AXIS FACE GEAR

INVENTOR
WAYNE J. HAMILTON

GOVERNMENT LICENSE RIGHTS

This invention was made with Government support under U.S. Government contract number DAAH10-01-2-0005. The Government has certain rights in this invention.

FIELD OF THE INVENTION

This invention relates generally to mechanical power transmission systems and, more specifically, to gearing arrangements for mechanical power transmission systems having skewed mechanical transmission shafts.

BACKGROUND OF THE INVENTION

Power transmission designers tend to avoid low shaft angles if possible but sometimes are constrained to use them. Current gear configurations are not optimized for these low angles and many times they have problems efficiently transferring power. This problem drives the gear designer to use larger and heavier gears. Currently, low shaft angles usually mean the use of crossed axis helical gears. Crossed axis helical gears are configured such that the resulting contact between gears is theoretically a point. This point takes the full load of the gear and thus the gear must be much larger and heavier to handle the full load.

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701 Fifth Avenue, Suite 4800
Seattle, Washington 98104
206.381.3300 • F: 206.381.3301

Therefore, there exists an unmet need for a lightweight gearing system that is capable to handle forces between shafts that are aligned at a low angle.

SUMMARY OF THE INVENTION

The present invention relates to mechanical power transmission systems and, more specifically, to gearing arrangements for misaligned mechanical power transmission systems. Apparatus and methods in accordance with the present invention may provide power transmission across misaligned gear joints with significant improvement in performance and reduction in weight, in comparison with comparable prior art devices.

In one embodiment, the present invention provides an adapter gear for allowing rotating shafts having a low angular difference to interact. The adapter gear may be used when new components are inserted into old systems, shaft alignment cannot be achieved, and the alignment is less than 30°. Various gears may be used, however the adapter gear of the present invention provides a strong lightweight solution that is important for many systems.

The adapter gear is a low angle face gear that includes a drum having an inner cylindrical wall adapted to be mounted on a shaft, and a drum face connected to the inner cylindrical wall. A gear ring is mounted on and fixed to the drum face and gear teeth are formed on an outer circumference of the gear ring. A vector normal to the gear teeth at a radial and a vector perpendicular to the inner cylindrical wall at the radial have an angular difference that is less than 30°.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred and alternative embodiments of the present invention are described in detail below with reference to the following drawings.

FIGURE 1 illustrates a gear formed in accordance with an embodiment of the present invention;

FIGURE 2 illustrates a top view of the gear of FIGURE 1;

FIGURE 3 illustrates a cross-sectional view of the gear of FIGURE 1;

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FIGURE 4 illustrates a portion of the gear of FIGURE 1; and,

FIGURE 5 illustrates the gear of FIGURE 1 implemented in an example system.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to gears and gearing systems. Many specific details of certain embodiments of the invention are set forth in the following description and in FIGURES 1-5 to provide a thorough understanding of such embodiments. One skilled in the art, however, will understand that the present invention may have additional embodiments, or that the present invention may be practiced without several of the details described in the following description.

FIGURE 1 illustrates a front view of an example low angle face gear 20 that transfers power between two shafts that have a low angle of variance between them. For example, in one particular embodiment, the gear 20 may be used to turn a first shaft from a connection with a gear on a second shaft, where the two shafts have a variance in their angles of 30° or less.

The low angle face gear 20 includes a cavity 22 that receives a shaft of a motor, transmission, or other type of mechanism. A face or drum 24 of the gear 20 surrounds the shaft cavity 22. The drum 24 preferably includes numerous circular cavities 26 for decreasing the overall weight of the gear 20 without sacrificing the structural support that the drum 24 provides. The gear 20 also includes a gear flange 30 that surrounds the drum 24. Located on an outside surface of the gear flange 30 are gears 32. The gear flange 30 is angled out of the plane of the gear 20. In other words, the normal to the surface of the drum 24 is different from the normal of the side surface of the gear flange 30. The angular distance between the two normals varies by a pre-defined amount depending upon the desired angular relationship that one wishes for the gear flange 30.

FIGURE 2 illustrates a top or side view of the gear 20 and FIGURE 3 illustrates a cross-sectional side or top view of the gear 20. FIGURES 2 and 3 further illustrate that the

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gears 32 are cantered/skewed at an angle as compared to the gears on a spur gear. In a spur gear, a normal to the plane of the gears is perpendicular to a shaft that is received by the spur gear.

FIGURE 4 illustrates a section 40 of the gear 20. The gear flange 30 with the gears 32 is angled such that the gear flange 30 is not perpendicular with a shaft received through the cavity 22. The angle of the gear flange 30 (see angle 48) is a pre-defined amount depending upon how or where the gear 20 is to be used. The angle 48 is equal to the difference between a vector Ng that is normal to the gears 32 a vector Vp perpendicular to a shaft received through the cavity 22. The angle 48 is generally equal to the angle between the shaft that the low angle face gear 20 receives and a shaft coupled to a spur gear that is linked with the low angle face gear 20.

FIGURE 5 illustrates an example implementation of the gear 20. The gear 20 is used to drive a transmission 60 from a connection to a spur gear 62 mounted on a motor driven shaft 70. In this example, the transmission 60 is a rotary aircraft transmission. The low angle face gear 20 allows a shaft 72 of the transmission 60 to not be quite parallel to the engine shaft 70. The low angle face gear 20 is coupled to the shaft 72 at a location where it links up with the spur gear 62 of the engine shaft 70. Essentially, the low angle face gear 20 is used as an adapter to compensate for the low angle variation between the two shafts 70 and 72.

The low angle face gear 20 may be used anywhere where adapting between shafts having low angled differentials is needed. Also, one can design engine and transmission systems that are not limited to high angled differences between shafts or strictly parallel shafts.

In one embodiment, the gears 32 of the low angle face gear 20 are created by a precision grinding method, such as that shown in U.S. Patent No. 5,823,857 to Tan, which is hereby incorporated by reference. When the gears 32 are produced in this manner, higher specific load capabilities are possible, because line contact occurs versus point contact.

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While the preferred embodiment of the invention has been illustrated and described, as noted above, many changes can be made without departing from the spirit and scope of the invention. Accordingly, the scope of the invention is not limited by the disclosure of the preferred embodiment. Instead, the invention should be determined entirely by reference to the claims that follow.

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